

Abstract

In textbook literature, the phenomenon of mutual inductance has been described in rigorous detail from the magnetic field-level behaviour all the way to equivalent circuit models, and these are valid for circuits consisting of any number of coils where there may be magnetic flux linkage. Unlike mutual inductance, the description of multi-body systems which exhibit electric flux coupling has not been carried through from a field level to equivalent circuit models in the same way. Most circuit models used to describe capacitive coupling are therefore different and cannot be easily compared.

In this dissertation, a general circuit model describing capacitive coupling is developed from field-level theory. This model is based on a four-body physical structure, and forms a restricted dual to the well-known two-body inductive coupling circuit model. A quantity representing coupling capacitance was defined and given the symbol S , and this quantity is the dual to the mutual inductance term commonly referred to by the symbol M in textbook literature. An in-depth analysis is documented into the coupling capacitance term S , showing that it is possible to obtain a system which exhibits positive, negative or zero coupling. Experimental verification was done for systems exhibiting zero coupling, 100 % coupling and arbitrary coupling. For all cases, the experimental results had very good agreement to the values predicted using the capacitive coupling circuit model.

The circuit properties of the capacitive coupling model hold in the same way as it does for inductive coupling, as expected of a dual model. In general, interconnections of capacitive coupled networks can also be made as long as specific conditions are met.

A concise discussion into different possible practical applications of the circuit model is then provided, together with circuit diagrams. This is followed by a detailed discussion into a condition-monitoring application for inductive (power) transformers. It is shown theoretically and experimentally that the capacitive coupling circuit model can be used in condition-monitoring of power transformers to detect mechanical movements of coils.

The dissertation is concluded with a discussion on possible future work.